

# Training and Measuring Creativity Using Computer-Based Morphological Analysis Method

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## Abstract

*The growing interest and concern in tapping creativity has prompted many research on creativity to be undertaken in a number of countries, particularly Malaysia. This paper explores the use of Information and Communication Technology (ICT) as educational technology tool for fostering and assessing the creative potentials of a person. A group of 97 university undergraduates, who are teacher trainees, took part in the study. In what way can a computer train and measure the creative potentials of a person? The assessment of creativity traits such as fluency, flexibility, elaboration and originality are based on definitions and algorithms adapted from Torrance's Test of Creative Thinking (TTCT) and Guilford's Alternative Task (Torrance & Ball, 1984 [43]; Guilford, 1977 [13]). Findings revealed that 85 out of the 97 subjects managed to improve their respective fluency, flexibility, elaboration and originality scores in the creativity exercise. The improvement of their creative potentials is credited to the effective implementation of the Morphological Analysis Method in the brainstorming activities. Findings also showed that there was an increase of 123 (or 48.8%) additional ideas as a result of the use of morphological matrix employed by this creativity technique. The study recommends the adoption of the Morphological Analysis Method for repeated uses on any academic curriculums in schools or universities/colleges to improve the creative potentials of a person on long term basis.*

KEYWORDS: creativity, morphological analysis, fluency, elaboration, flexibility, originality, multimedia

## Introduction

A lot of people tend to think of a “creative person” as eccentric or may be “insane” (of the ways he handles things unusually). The communities perceive such people as creative due to the outcomes of their hard work; solving problems in a novel, yet appropriate way. These anomalies have prompted the author to be motivated to examine the causes of creativity and how creativity can be fostered, nurtured or improved by using the latest all important tool of productivity, multimedia.

The paper examines the crucial question of whether Information and Communication Technology (ICT) can help making the job of creativity assessment easier and faster and at the same time plays its role in fostering creativity. Conventional methods using manually drawn graphics are time-consuming process in term of assignment of scores to the tests (if it is not in objective format).

This research is designed to investigate the possibility of training and assessing creativity using multimedia and a computer-based assessment system. The proposed integrated system is carefully planned, designed, developed and tested on a group of university undergraduates for its effectiveness and reliability in evaluating creative potentials of a person.

## Research Questions

This research is designed to examine and answer the following research questions:

1. In what ways can ICT (multimedia) help to improve creativity?
2. What components of creativity are used to indicate creativity improvement?
3. How do the creative potentials of a person improve?

## Review of Literature

### *The use of multimedia for training creativity*

Creativity is often known as a characteristic that a person possesses, a product or outcome that is regarded as original, and a process by which an unusual, novel or suitable outcome or solution is obtained. Creativity involves the exercise of *imagination*. Creativity can be examined in a form of:

- product or behaviour (Besemer & Treffinger, 1981 [3])
- personality (Gardner, 1983 [11])
- thinking and learning styles (Sternberg, 1985 [40])
- environmental and social psychological settings such as motivation and work place (Amabile, 1982 [2]) and social-economic factors
- creativity processes were such as thinking processes (cognition and meta-cognition)
- stages of creativity (Csikszentmihalyi, 1996 [8]; Loveless, 2002 [16]; Mansfield & Busse, 1981 [18]; Shneiderman, 2000 [37]; 2002a [38]; 2002b [39])

For example: Shneiderman's Model: Collect, Relate, Create, Donate

Numerous researchers argue that creativity can be taught and increased (Cropley, 2001 [7]; Davis, 1999 [9]; Houtz, 2003 [14]; Treffinger & Isaksen, 2001 [46]; Onda, 1994 [27]; Torrance & Safter, 1999 [44]). In this research, multimedia courseware that upholds the principles of multimedia of self-access, self-directed and self-paced is used in creativity training. According to Schwier and Misanchuk (1993) [35], multimedia courseware must have interactive learning components and practices that come with responses and suitable feedbacks. Carefully designed multimedia courseware that are consistent with how people learn, can aid learner greatly (Liou, 1994 [15]; Mayer, 1997 [19]; 1999a [20]; 1999b [21]).

Incorporation of video sequences and animations into multimedia courseware help teachers to tackle many misconceptions that students have and which are difficult to address within the limitations of chalk, textbook and overhead projector. The development of quality computer graphics is also essential to presenting visual ideas clearly to explain concepts. Voice, which is narrated audio, and music are types of audio that can aid learning in multimedia courseware (Mayer, 2003 [22]).

Animation is also a highly effective tool for illustrating a concept (Roblyer, 2003 [31]). The purposely-created motion can also illustrate processes and real-life or virtual environment. Animations are processed in the visual or pictorial channel (Mayer, 2003 [22]). But, unfortunately, learners can only able to mentally activate for about ten seconds of the animation at any one time.

### *The Training and Assessment of Creativity*

This research uses brainstorming and the Morphological Analysis (MA) Method in fostering creativity. Brainstorming is an activity that encourages lateral thinking and a great contributor to creativity and innovations because it gathers all ideas (without pre-judging any of them) into a solution-bank for the next stages of the creativity process (Muttagi, 1981 [25]; Rawlinson, 2004 [30]; Vidal *et al.*, 2004 [47]). The running of brainstorming is usually based on the following principles:

- Criticism is ruled out
- Freewheeling is welcomed
- Quantity is wanted
- Combination and improvement are sought

The creation of a relaxed and judgement-free atmosphere encourages the flow of ideas which will be severely impeded if participants are allowed to convey their judgement on each idea (Majaro, 1988 [17]). To ensure all ideas are accepted, the power of imagination is highly encouraged. In other words, the brainstorming session may produce any idea that can solve the problem, be it wild, insane, practical or even impractical idea.

With the growth of online services, brainstorming activities has gone online with a new term known as brainlining (combines the words 'brainstorming' and 'online') (Proctor, 1999) [29]. In this research, an 'asynchronous' (offline) type of brainstorming is created (Binder & Binder, 2007 [4]) to be used together with the MA Method. The morphological box or morphological matrix was created by Dr Fritz Zwicky, a Swiss astrophysicist based at the California Institute of Technology (Michalko, 1991 [23]) and it can generate a very large number of solution concepts for a problem under investigation (Roy, 2004 [34]).

It works through the processes of *breakdown* and *association* (Roy, 2004 [34]). For example, a problem on "Future transportation" can be *broken down* into two variables; type and power. The "type" variable has "ground, air, space" components while the "power" variable has "petrol, electric, solar, battery" components. The *association* of "ground" and "solar" sub-variables can result in the new idea of "solar-powered robot transport machine". Theoretically, this MA matrix is capable of producing 3 x 4 or 12 ideas (two-dimensional analysis). However, multi-dimensional MA will produce unlimited ideas, possibly millions of ideas of which Aleinikov (2002) [1] terms as the "mega-creativity" stage.

Presently, there are over 200 techniques used for the fostering of the creative potentials of a person (Rawlinson, 2004 [30]). Some of these techniques are attribute listing, mind-mapping, check lists, forced relationships, 5 W's and H, lateral thinking and PO, metaphorical thinking and etc. The MA Method is chosen because it encourages the breakdown of a problem into easily approachable components and thereby increases the possibilities of getting more solutions and hence increases the fluency of ideas production (Aleinikov, 2002 [1]; Rawlinson, 2004 [30]).

## **Methodology, Sampling and Procedure**

This research uses program evaluation approach. Program evaluation is the systematic collection of information about the activities and outcomes of programs to improve effectiveness and make decisions with regard to what those programs are doing and affecting (Patton, 1994 [28]; Clarke and Dawson, 1999 [6]). The formative – summative evaluation approach is suitable for evaluating training programs (Scriven, 1967 [36]; Robson, 2000 [32]; Morrow et al., 2006 [24]; O'Sullivan, 2004 [26]). According to Scriven (1967) [36], formative evaluation is evaluation done to provide feedbacks for program improvement. Its primary objective is to support the process of improvement.

It is also known as "developmental evaluation" by Patton (1994) [28]. In summative evaluation, Scriven said that the principal aim of the exercise is to determine the overall effectiveness or impact of a program with a view to recommending whether or not it should continue to run. According to Clarke and Dawson (1999) [6], the formative – summative approach is appropriate because formative evaluation is "process-oriented" which focuses on improving program development while summative evaluation is "conclusion-oriented" which usually indicates whether or not the program needs to continue at the end of the training session.

The population of this research is all final year undergraduates (N = 172) of the education faculty of a public university in the state of Sabah, Malaysia. A total of 110 subjects are selected and ticked randomly from the name list supplied by the faculty. Finally, only 97 subjects from two academic disciplines (TESL and Science) managed to participate in the program.

Before the training, the 97 subjects are required to do Practice 1 (formative evaluation of the program) which is a brainstorming activity. They are allowed to access the multimedia training for knowledge on the brainstorming strategy. After completing Practice 1, they are requested to go through the multimedia presentation again to learn another creativity technique known as Morphology Matrix (Morphology Analysis) Method. When they are satisfied with what they learn, they do Practice 2 (summative evaluation).

## Instrument

The focus of this research is to measure the creativity traits of the subjects in term of fluency, elaboration, flexibility and originality. Measurement of creativity is based on the derived formula adapted from Torrance's Test of Creative Thinking (TTCT). For the record, the Torrance's TTCT is the most popular creativity test battery and also has the most complete scoring guides, norms and longitudinal validity (Torrance, 1990 [41]; Torrance & Wu, 1981 [45]). Its reliability coefficient ranges from .78 to 1.00, at different grade levels (Torrance, 2000 [42]). The criterion for the assessment of the creative potentials of a person is shown on Table 1.

Table 1: Scoring criteria for creativity constructs and Creativity Index  
(adapted and adopted for use in this research from Torrance & Ball, 1984 [43]; Guilford, 1977 [13])

Creativity components	Scoring criteria	Score awarded
Fluency (F)	The number of different ideas that one can produce	1 point for each idea
Elaboration (E)	Richness of detail in the ideas that one produces	1 point for each creative elaboration
Flexibility (FX)	The number of categories of ideas that one produces	1 point for each category
Originality (O)	The uniqueness of the ideas that one produces as compared to the whole sample	Between 1% and 5% = 1 point If 1% = 2 points

The chosen brainstorming topic for the Practice 1 and Practice 2 is "Future Transportation in Malaysia". The test-retest reliability for the topic is  $r = .497$  and it is significant at 99% confidence level. The principle of creativity measurement purely lies with divergent thinking and hence 'the number of ideas produced' contributed to the fluency component. For example, 10 ideas contributed brought 10 points for a person's creativity indicator (fluency). There is no right or wrong answers for the topic. The principle of creativity states that there is no such thing as 'wrong idea' because all ideas are accepted. An illustration of the measurement of creativity into the four components of creativity is shown in Figure 1.

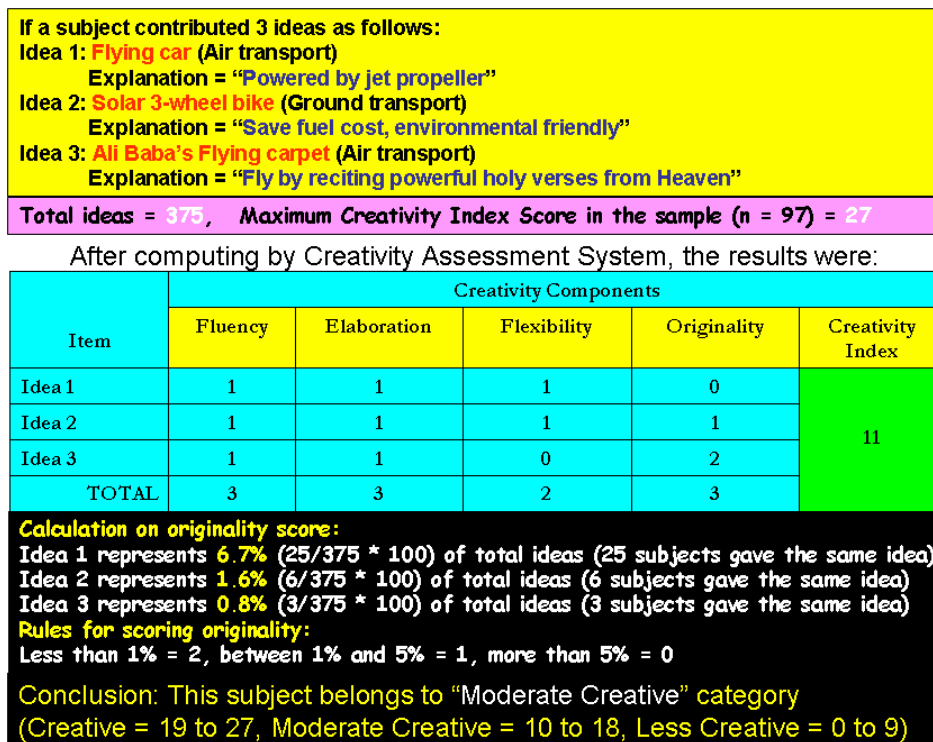


Figure 1: Assessment of creativity components: fluency, elaboration, flexibility and originality

A pilot run of the integrated system showed that the anticipated results tallied 100% correctly with manually calculated results. An interview is also used to gauge the respondents' opinions on the MA Method in term of its implementation, effectiveness and problems. The interview has 6 open-ended items.

## Findings and Discussion

### *Improving creative potentials via multimedia*

The training modules used in this research contains all the five multimedia components. They are text, graphics, audio, video and animation. The multimedia modules used in this research are complete with definitions, explanations, examples (in multimedia format especially animations) related to the creativity techniques employed. Besides that, practices with guided solutions are also included in the system. This is to enforce scaffolding or knowledge enhancement that acts as support and guidance to problem solving that can be beyond the possession of the current knowledge (the MA Method) (Rogoff, 1990 [33]).

The training modules are designed and presented in a form of video because it is accepted as a highly effective tool for illustrating concepts (Roblyer, 2003 [31]; Brooks *et al.*, 2001 [5]). This view is also supported by William and Abraham (1995) (in Brooks *et al.*, 2001 [5]). Although video is considered effective in delivering instruction but unfortunately, learners can only able to mentally activate for about ten seconds of the animation only at any one time (Mayer, 2003 [22]). To tackle this problem, option for *replaying* video is made available and is activated at all time so that slower learner can replay it at any time without any limit or condition. The research findings showed that 85 out of 97 subjects (87.6%) managed to improve their respective creativity scores in Practice 2 (summative evaluation) after going through the training modules. This indicated to a certain extent that the training is successful.

### *The improvement of creative potentials*

Many researchers believe and to a certain extent prove that the creative potentials of a person can improve (Cropley, 2001 [7]; Davis, 1999 [9]; Houtz, 2003 [14]; Treffinger & Isaksen, 2001 [46]; Onda, 1994 [27]; Torrance & Safter, 1999 [44]). The research findings on the creativity achievement for the 97 subjects is summarised in Table 2.

Table 2 Summary of creativity achievement: Comparisons of means

Creativity Components	Practice 1 (SD)	Practice 2 (SD)	Difference	T-test Result at 95% confidence level
Fluency	3.87 (1.68)	6.46 (2.71)	2.59	Significant (t = -10.94, p < .05)
Elaboration	3.82 (1.70)	6.42 (2.68)	2.60	Significant (t = -10.90, p < .05)
Flexibility	3.22 (1.42)	4.49 (1.28)	1.27	Significant (t = -8.61, p < .05)
Originality	7.00 (3.27)	12.03 (5.23)	5.03	Significant (t = -10.30, p < .05)

From Table 2, we can see that there is an increase in means in every creativity component. The differences in the means are all tested with t-test and the result also indicated significance for all the components at 95% confidence level. This proved that the subjects had improved their creativity scores in Practice 2. The improvement of creativity scores in Practice 2 can be traced back to the increased number of ideas the subjects posted to the system. There is an increase of 252 ideas in Practice 2's ideas bank from 375 ideas (Practice 1) to 627 ideas (Practice 2).

The MA Method succeeded in improving the skills of the subjects to enhance ideas generations in Practice 2. As creativity experts put it, the more ideas a person can generate meant that the more innovations can to be accomplished as suggested by the divergent thinking process as explained in the Structure of Intelligence Model (Guilford, 1967 [12]; 1977 [13]). This view is also supported by DeBono (1990) [10] who reiterates that lateral thinking (divergent thinking) is an effective method for enhancing creativity and problem solving.

The MA technique is successful because the brainstorming topic "Future Transportation in Malaysia" is broken into 2 variables namely; "type of transport" (y-axis) and "source of power for transport" (x-axis). This

creates a 6 by 6 Morphological Matrix that can generate up to 36 ideas for each subject. The matrix makes the subjects more organised when they brainstorm for ideas.

The interview which was administered after the completion of Practice 2 shows the following results:

- Can MA Method help you to contribute more ideas? (97.9% subjects said ‘Yes’)
- Morphology Analysis organised my thoughts on ideas (74.2% subjects said ‘Yes’)
- Morphology Analysis is systematic and easy to use (63.9% subjects said ‘Yes’)
- The MA's matrix item intersections kept me in focus on ideas (75.3% subjects said ‘Yes’)

In examining the opinions of the subjects on whether the MA Method helps them in contributing more ideas, 95 subjects or 97.9% agreed so. As explained earlier, the MA Method is a matrix bordered by the x-axis and y-axis. The intersection of two sub-variables of the matrix helps the subjects to think of the ideas.

For example, the intersection between ‘ground’ sub-variable on the y-axis and ‘soul’ sub-variable on the x-axis results with the idea; ‘bed transport’ (refer Figure 2). This idea sounds crazy, mad and illogical but in the ‘suspend judgement’ principle practised in brainstorming technique, it is allowed and accepted by the system. Who knows that in the future, some geniuses may take up this idea seriously and go on to design and invent it, so that when we wake up from our sleep we have reached our desired destination. Although the idea sounds crazy but this is just what is meant by creativity.

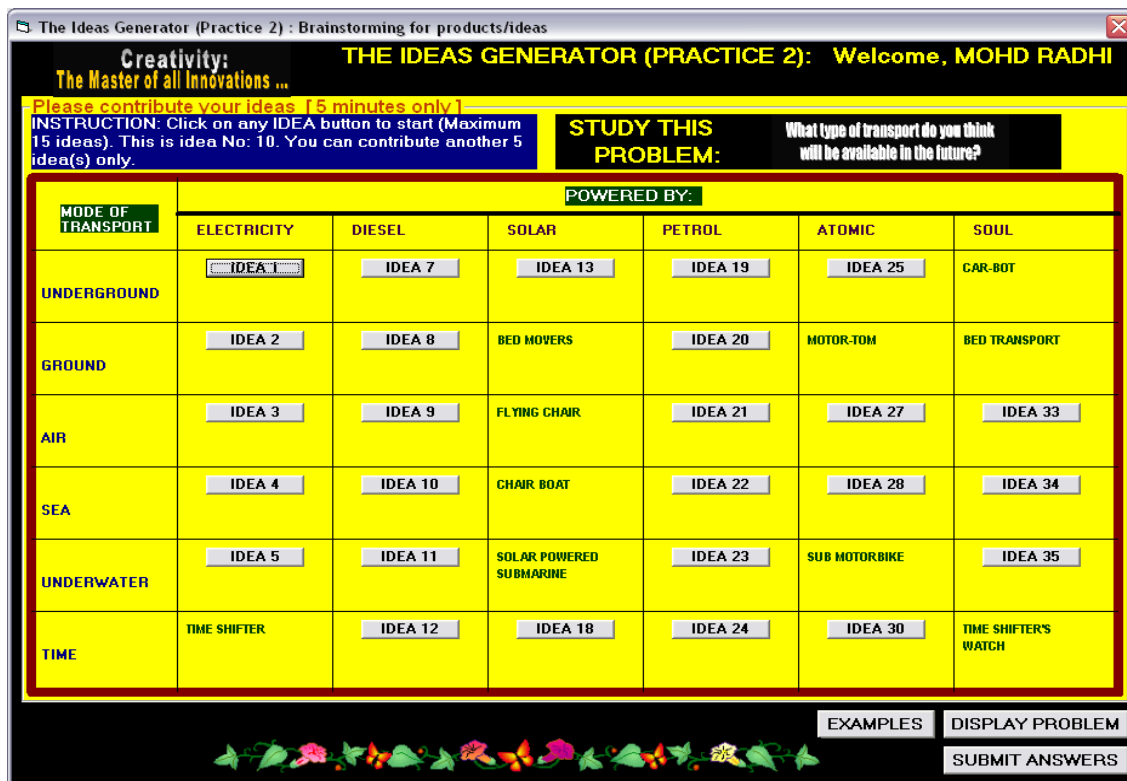


Figure 2: Screen shot of the morphology matrix in Practice 2

The interfaces shown on Figure 2 also demonstrate that they are easy to use (63.9% or 62 subjects agreed to this view). When a subject needs to contribute idea for a particular selected intersection, he will just click on that particular idea button. 75.3% or 73 subjects are also of the opinion that MA is not only easy to use but also helps the user to keep focus on only thinking of the required type of idea only. When the subjects are focus in thoughts, thinking is quite systematic and organised. This opinion is again supported by 74.2% of them (72 subjects). In other words, when thoughts are not organized (as in Practice 1) they are forced to search for ideas randomly at all possible

places mentally and the MA Method does a great favour by helping them to keep focused and concentrated via the respective intersections of the matrix.

## Recommendation

The study is able to prove the effectiveness of the morphological matrix in the MA Method in promoting creative problem solving. It is therefore recommended that this method can be adapted to suit academic activities (in schools or universities/colleges) that require brainstorming for ideas. The repeated uses of this technique will definitely improve the creative potentials of a person in the long term.

## Conclusion

The conclusion for this research is that the creativity technique, MA Method is able to stimulate brainstorming and proved to be able to produce more ideas than before. However, it must be noted that this achievement will only be successful if judgement of ideas is delayed or suspended as recommended by brainstorming experts (DeBono, 1990 [10]; Rawlinson, 2004 [30]). The multimedia training is also successful in departing precise and useful information on the correct use of the MA Method. I will conclude that the improvement of creativity of the subjects is due to the combinations of right learning attitude of the subjects towards learning the MA Method, the effective roles of the MA matrix and the successful completion of both Practice 1 and Practice 2 by the sample subjects.

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